Technology Focus: Using Technology to Explore Statistical Inference

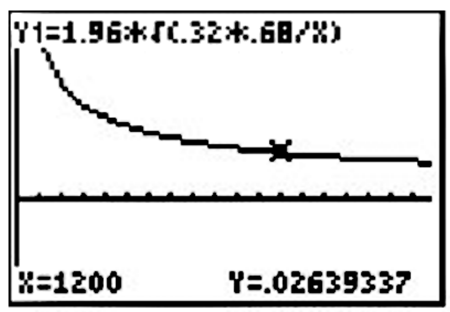
Joe Garofalo and Nicole Juersivich

There is much research that documents what many teachers know, that students struggle with many concepts in probability and statistics. Here are two sample activities we use to help our pre-service teachers develop ideas about how they can use technology to promote their students' ability to understand mathematics and connect their in-school learning to situations outside of school.

Activity 1: Graphing the Margin of Error. We typically present students with actual poll results reported the morning of a class, like the poll results shown below:

A CNN/Opinion Research Corporation poll conducted February 1-3, 2008 asked 1,192 adults nationwide the following question: "Do you approve or disapprove of the way George Bush is handling his job as president?" The pollsters reported that 32% of the respondents approved, while 67 percent of the respondents disapproved, with a margin of error of ±3.

We ask students, most of whom are mathematics majors who completed two courses in probability and statistics, to explain the meaning of a margin of error. Most just respond that a margin of error of ±3 means that the true percentage of adults who approve of Bush's job performance is between 29 and 35%. This interpretation is no different from the interpretations given by adults with little or no formal knowledge of mathematics. Most of these students cannot explain how the pollsters determined this margin, nor can they explain why this sample size is reasonable for a national poll. After some leading questions, many of these students recognize that this is an application of a one-proportion Z-test with a 95% confidence interval. We then suggest that they view the expression for the standard error not as a formula [$1.96\sqrt{(p(1-p)/n)}$], as is typically done, but as a function of sample size. By graphing and tracing this function students can not only verify the margin of error for this poll (±2.6%), but they easily calculate the margin of error for different samples sizes. Furthermore, by just observing the shape of this graph they can see that increasing the sample size past 1200 does not have much of an effect on the margin of error. In fact, tracing the graph shows that one will need to sample about 10,000 adults to have a margin of size of ±1.0%. Students then use this diminishing return to explain why pollsters often sample around 1,100 adults.



These students, like too many others, cannot readily connect their study of mathematics, in this case inferential statistics, to realistic situations, even though they can solve the pseudo-realistic problems found in their textbooks. They need more experiences applying what they are learning in classrooms to situations outside of their classrooms and textbooks. Context matters!

This example demonstrates that it can be instructive for students to think of formulas as functions to be analyzed, rather than just as expressions into which they can plug numbers. Another powerful example of the usefulness of

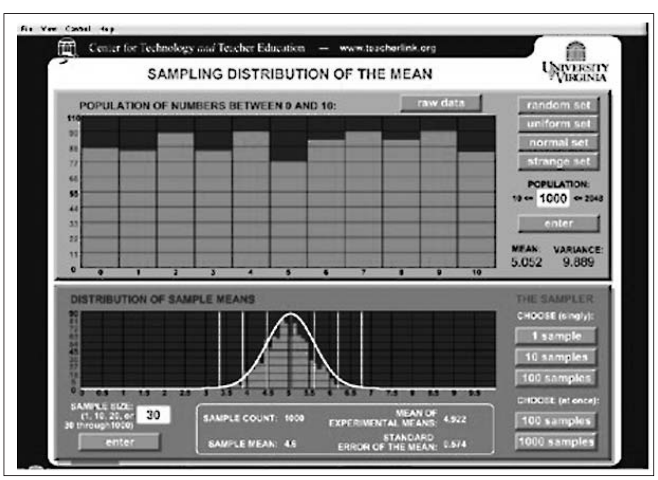
Joe Garogalo is Co-director of the Center for Technology and Teacher Education at the University of Virginia.

Nicole Jersivich is a graduate student in the Curry School of Education at the Univeristy of Virginia.

taking a “functions approach” to a formula is to analyze the graph of monthly loan payment as a function of the number of months for which money is borrowed. Try this for you own mortgage numbers!

Activity 2: Sampling distribution of the mean

Another reason why many students have difficulty applying statistical inference tests outside of their course and textbook tasks is that too many of them do not understand the underlying conceptual basis of statistical inference. Some students have trouble deriving meaning from static textbook graphs coupled with algebraic representations. To help address this issue, we developed a “Sampling Distribution” Flash tool that allows students to choose samples from a population and observe the distributions of the means of these samples. One can choose from 4 population distributions of numbers from 1 to 10, and vary the population size, number of samples taken from the population, and the size of the samples. The screenshot below shows the distribution of the means of 1000 samples of size 30, taken from a random population of 1000 numbers.



Teachers can use this tool to pose and answer a variety of questions regarding sampling distributions. Students can see, for example, how changes in the number of samples taken and changes in sample size can affect the distribution of sample means. By observing these changes systematically, students are able to answer various “why” and explanation questions, such as: Can you explain why the distributions of means of large samples are narrower than those of smaller? Both Windows and Mac versions of this Flash file can be freely downloaded from our Flash page: www.teacherlink.org/content/math/interactive/flash/home.html.

The above approaches can be used in conjunction with current newspaper, television, and online reports concerning the presidential election and many other issues that pollsters are studying. Tasks like these can help students answer for themselves a recurring question asked by many high school students: Why should we learn this?